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EUROCONTROL EXPERIMENTAL CENTRE

TEST DATA-LINK PROCESSOR
(UNIX Version)
Volume 1

EEC Note N° 16/95
Task No. AT58
EATCHIP Task Specification FCO.ET3.ST08

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TEST DATA-LINK PROCESSOR - UNIX Version
Volume 1

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Abstract :

This note describes the Mode-S UNIX based Test Data Link Processor (TDLP) which was developed by the EUROCONTROL Experimental Cerntre.

The TDLP is available to emulate a Mode-S Data Link Processor (DLPU) for test and experiments where a ruggedized and certified system is not required. Being UNIX workstation based, the TDLP can be operated remotely in a network architecture. The TDLP can be upgraded to emulate an Aircraft Data Link Processor (ADLP).

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TEST DATA-LINK PROCESSOR
(UNIX Version)
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by

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Summary

This note describes the Mode-S UNIX based Test Data Link Processor (TDLP) which was developed by the EUROCONTROL Experimental Cerntre.

The TDLP is available to emulate a Mode-S Data Link Processor (DLPU) for test and experiments where a ruggedized and certified system is not required. Being UNIX workstation based, the TDLP can be operated remotely in a network architecture. The TDLP can be upgraded to emulate an Aircraft Data Link Processor (ADLP).

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I. INTRODUCTION

1. ACRONYMS AND ABBREVIATIONS DEFINITIONS

AAC	Advanced ARINC Card
AGLAE	Air Ground Data Link Applications Experimentation System
CENA	Centre d'Etudes de la Navigation Aérienne
DII	Downlink Interrogator Identification
DLPU	Data Link Processor Unit
EFMS	Experimental Flight Management System
GICB	Ground Initiated Comm-B Messages
ICAO	International Civil Aviation Organisation
STNA	Service Technique de la Navigation Aérienne
TRT	Télécommunications Radio-électriques et Téléphoniques
XPDR	Transponder

2. PURPOSE AND SCOPE

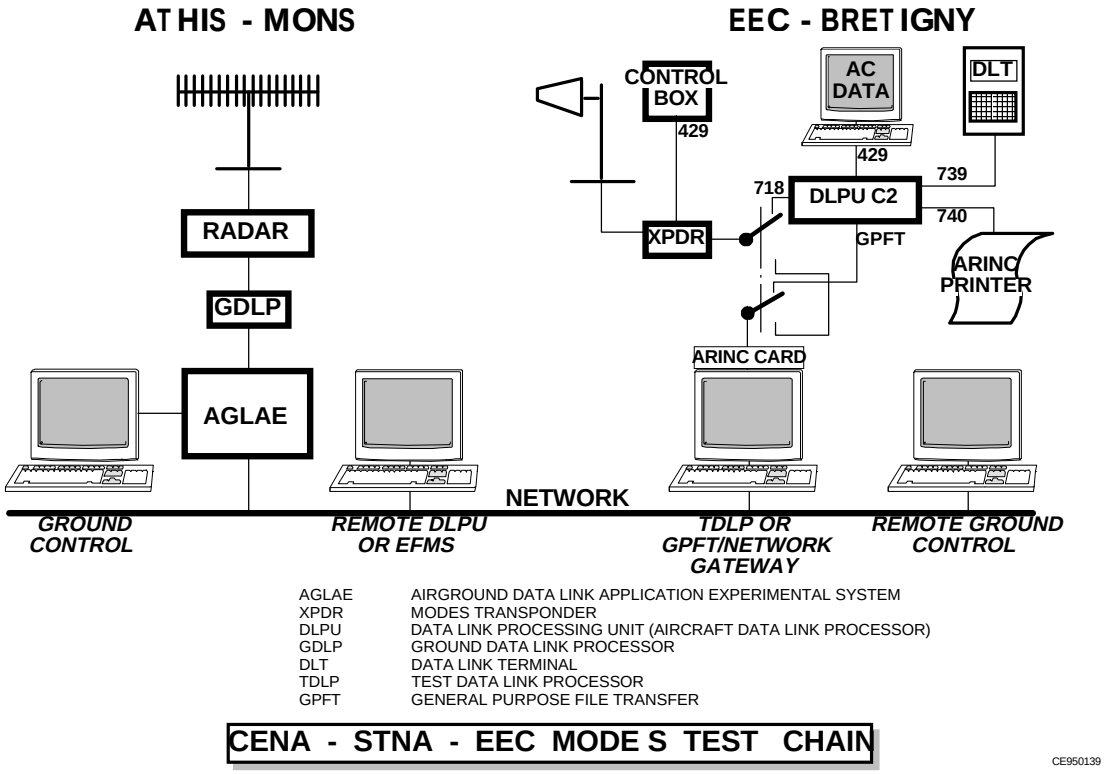
The purpose of this document is to provide functional description and user manual necessary to operate the UNIX-based Test Data Link Processor (TDLP) developed at the EUROCONTROL Experimental Centre. The description of all processes running in the workstation, of the interface driver with the Advanced ARINC Card - version 2, and of the firmware installed in the ARINC card is made in Volume 2.

The description of the ARINC 718 protocol can be found in several documents mentioned in the reference chapter.

A PC-based version of TDLP was first built and documented in EEC Note No. 19/93. Following a demand of more functionality, it became obvious that this application should be ported to a multi-task software environment as UNIX, using a workstation as hardware platform.

This enables remote-running the program which shows to be a significant advantage for Mode-S experiments.

II. GENERAL OVERVIEW



Note : DLPU C2 and DLT can be replaced by the UNIX based-TDLP.

Figure No. 1 : CENA-STNA-EEC Mode-S Test Chain

The main application of the workstation based TDLP is a data link processor for a Mode-S fixed transponder, which can be remote controlled via standard networks. ***Figure No. 1*** above shows the joint EEC - CENA - STNA Mode-S test chain composed of the Mode-S radar at Orly, the experimental Mode-S ground control at Athis-Mons and the Mode-S aircraft environment at Brétigny.

The test chain can be used for several purposes. The two major ones are :

Tests at Brétigny :

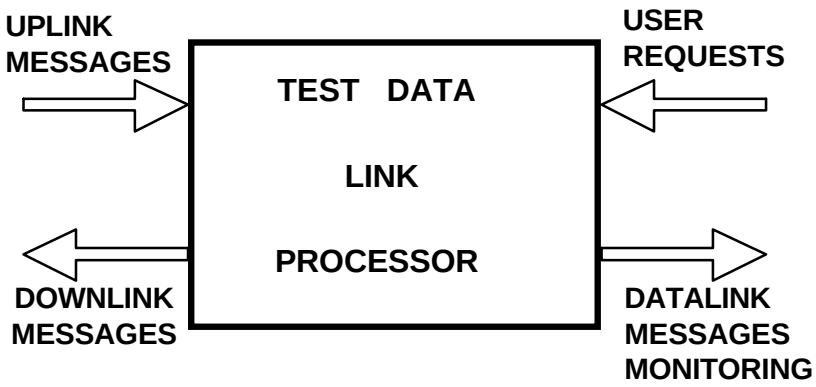
An airborne DLPU Model C2 is connected to the Mode-S XPDR connected to a Data Link Terminal, a cockpit printer and an aircraft data simulator. A workstation is remotely connected to the ground control at Athis-Mons. End to end tests can be conducted at EEC Brétigny.

Tests at Athis-Mons :

The UNIX-based TDLP equipped with an ARINC card is connected to the XPDR. Thanks to UNIX multi-task environment, the different peripherals of the DLPU are simulated, including messages generation, messages display, aircraft data variation and the triggering of pre-prepared downlink messages by pressing keyboard keys for special test purposes. The workstation based TDLP can be used in a remote mode from Athis-Mons to conduct end to end tests.

III. THE TEST DATA LINK PROCESSOR

1. GENERAL ASPECTS



ce950610

Figure No. 2 : TDLP General Overview

This Mode-S test tool implemented in a HP-UX workstation is basically an upgraded version of the one written for PC-AT in a DOS environment mentioned above. Supporting ARINC 718 dialogue protocol for downlink and uplink messages the TDLP is also a user interface for monitoring and generating message transfers.

In terms of software a new operating system was used. HP-UX represents a good choice even if UNIX is not completely acceptable as a real time system. Using several HP-UX IPC facilities, a range of processes were created increasing TDLP functionality.

The firmware was made more powerful in supporting a major part of the dialogue protocol with the Mode-S Transponder (XPDR). This is due to the production of the second version of the Advanced ARINC Card (EEC Note No. 17/94), more versatile and using time analysis. This card is able to recognise link failure or control ARINC 718 dialogue protocol synchronisation.

The production of a driver by HEWLETT-PACKARD France became also necessary to implement an interface capable of data transfer between the card firmware and the TDLP.

2. HARDWARE ENVIRONMENT

The TDLP was developed and implemented on a HP workstation Model 725/50.

Due to real-time constraints, it became necessary to allocate the workstation processing capacity for this task only. To run the program in a remote way, a network connection was implemented. The AAC - version 2, was installed on a PC-EISA slot of the workstation.

3. SOFTWARE ENVIRONMENT

All the TDLP processes were written in HP-UX C.

The assembler program that runs in the Advanced ARINC Card is the "XPDR.EXE" which is an upgraded version of the one used for the TDLP-PC version mentioned above which was written in Microsoft Macro ASSEMBLER.

The driver that implements the data exchange between the card firmware and the workstation Kernel, was also written in HP-UX

4. TDLP SOFTWARE ARCHITECTURAL DESIGN

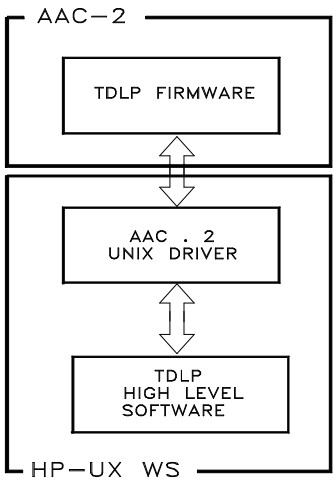


Figure No. 3 : TDLP Software Architectural Design

The TDLP architectural design is split in 3 software platforms, as shown above :

- Low level, TDLP firmware,
- Intermediate level, UNIX driver,
- High level software running in the workstation.

Detailed system documentation is available in Volume 2.

5. TDLP USER MANUAL

5.1. Introduction

The purpose of this chapter is to give a general overview of how a user can implement this software package and, at the same time, to describe how to use all the TDLP software facilities.

To run the Test Data Link Processor, it is necessary to have the following files :

"xpdr.exe"	AAC firmware
"gicb.dat"	Default file with AVIONICS data
"SETUP"	Set-up data concerns radar identification (DII) and ICAO airports codes for the phrase coded messages in the set-up editor process
"MES.TXT"	File containing the downlink messages written by the user
"tdlp"	File script to start running the TDLP
"bdsedit"	Editor for the "GICB.DAT" file
"gg"	GIGB messages generator
"ph"	User interface for editing or sending downlink messages
"fo"	Format downlink messages
"phs"	Editor for the set-up file ("SETUP"**)**
"xtu"	Format uplink messages
"prin"	Display uplink messages
"st"	Scans "MES.TXT" status
"xt"	Main process to implement the data link

The complete list of files should also include obviously the driver necessary to establish the connection between the AAC and this software application.

5.2. Starting TDLP

To start running the user should type "tdlp", see ***Photo 1***. This script file before activating the 9 processes mentioned above ask the name of the GICB file.

If nothing is written, after having pressed <ENTER> key, the default file "gicb.dat" is read by default, see ***Photo 2***.

Each of the 9 processes activated are running in a single « hpterm » visual window, see ***Photo 2***.

USER-DOWNLINK-INTERFACE	⇒	« ph »
UPLINK-DISPLAY	⇒	« prim »
GICB-GENERATION	⇒	« gg »
DOWNLINK-FORMAT	⇒	« fo »
SETUP-EDITOR	⇒	« phs »
MAIN-PROCESS	⇒	« xt »
GICB-EDITOR-gicb.dat	⇒	« bdsedit » with the file « gicb.dat »
UPLINK-FORMAT	⇒	« xtu »
MESS-TXT-STATUS	⇒	« st »

Use the mouse to select the correspondant « hpterm » window. How to operate with all processes will be described in the next Chapter.

5.3. Operating Instructions

5.3.1. GICB_EDITOR

5.3.1.1. The GICB_EDITOR is an on-line editor to simulate AVIONICS data. Data can be introduced having as parameters the BDS number, the resolution and the minimum and maximum value accepted.

BDS	DATA	RANGE	RESOLUTION
40	Flight Path Angle Flight Path Acceleration Corrected Angle of Attack Barometric Correction Altitude	± 180° 4 g ± 180° 131.072 ft	0,18° 0,001 g 0,044° 8 ft
50	Mach Number Computed Air Speed Track Angle True	4,096 Mach 1.024 Kt ± 180°	0,001 Mach 0,5 Kt 0,044°

	Track Angle Magnetic	± 180°	0,044°

BDS	DATA	RANGE	RESOLUTION
60	Track Angle Magnetic Ground Speed Altitude Rate Static Air Temperature	± 180° 2048 Kt ± 16.384 ft/min ± 512°	0,044° 0,5 Kt 64 ft/min 0,5°
70	Selected Altitude Range Selected Heading Status Word 1 Status Word 2	65.536 ft ± 180° 270 271	16 ft 0,8° Binary Input Binary Input
80	Selected Airspeed Selected Altitude Rate Selected Altitude Status Word 1	512 Kt 16.384 ft/min 45.536 ft Label 270	0,25 Kt 16 ft/min 16 ft Binary Input
90	Selected Mach Number Selected Altitude Rate Selected Altitude Status Word 2	4,096 Mach 16.834 ft/min 65.536 ft Label 271	0,002 Mach 16 ft/min 16 ft Binary Input
AO	Cross Track Error Vertical Deviation Acceleration	128 nm 2.048 ft ± 1 g	0,004 nm 1 ft 0,016 g
BO	Computer Airspeed True Airspeed Mach Heading (magnetic)	1.024 Kt 2.048 Kt 4,096 Mach ± 180°	0,25 Kt 0,5 Kt 0,00025 Mach 0,18°
21	Magnetic Heading True Air Speed Static Air Temperature Normal Acceleration	± 180° 2.048 Kt ± 512°C ± 1 g	0,18° 0,5 Kt 0,5° C 0,016 g
31	Bearing to Waypoint Time to Go Distance to go	± 180° 399,9 min 399,9 nm	0,18° 0,1 min 0,1 nm
41	Active Waypoint 1 Active Waypoint 2	3 characters 3 characters	ISO 5 ISO 5

	Desired Track	± 180°	0,18°

BDS	DATA	RANGE	RESOLUTION
51	Latitude Longitude Altitude	± 90° ± 180° 131.072 ft	0,00035° 0,0007° 8 ft
61	G.M.T. Flight Number	HHMMSS xxxx	
71	Roll Angle Altitude Rate Wind Speed Wind Angle	± 90° ± 8.192 ft/min 256 Kt ± 180°	0,35° 128 ft/min 1 Kt 0,703°
CO	Radio Height Average Static Pressure Altitude	8.192 ft 1.024 mb 131.072 ft	1 ft 0,25 mb 1 ft
24	Centre of Gravity Gross Weight	99,9 % 131.072 lbs	0,1 % 160 lbs
17	N1 Actual Engine # 1 Fuel Flow Engine # 1 Total Air Temperature Static Air Temperature	256 % rpm 32.768 lb/hr ± 512°C ± 512°C	0,13 % rpm 8 lb/hr 0,5°C 0,5°C
27	N1 Actual Engine # 2 Fuel Flow Engine # 2 Total Air Temperature Static Air Temperature	256 % rpm 32.768 lb/hr ± 512°C ± 512°C	0,13 % rpm 8 lb/hr 0,5°C 0,5°C
37	N1 Actual Engine # 3 Fuel Flow Engine # 3 Total Air Temperature Static Air Temperature	256 % rpm 32.768 lb/hr ± 512°C ± 512°C	0,13 % rpm 8 lb/hr 0,5°C 0,5°C
47	N1 Actual Engine # 4 Fuel Flow Engine # 4 Total Air Temperature Static Air Temperature	256 % rpm 32.768 lb/hr ± 512°C ± 512°C	0,13 % rpm 8 lb/hr 0,5°C 0,5°C

BDS	DATA	RANGE	RESOLUTION
1A	Aircraft Identification Aircraft Identification Aircraft Identification	2 char. ISO5 2 char. ISO5 2 char. ISO5	Label 233 Label 234 Label 235
1B	Aircraft Identification Aircraft identification	2 char. ISO5 2 char. ISO5	Label 236 Label 237

5.3.2. GICB_GENERATION

This is done automatically.

5.3.3. USER_DOWNLINK_INTERFACE

5.3.3.1. The USER_DOWNLINK_INTERFACE process permits to send or edit downlink messages depending of the following options :

"a" or "A" Permits editing "ATC" messages for immediate downlink request.
To finish editing type <ENTER>.

"w" or "W" Permits editing "WEATHER" messages for immediate downlink request.
To finish editing type <ENTER>.

For "ATC" or "WEATHER" messages, the maximum size is 208 characters which in 6 bit coding corresponds to a COMM-C of 16 segments.

For smaller messages, use "*" to indicate message end.

"s" or "S" The user can implement up to 100 messages for downlink purposes (6 bit coding). These messages can be written in file "MES.TXT".

15 messages are already existing and can be activated by typing the corresponding number, as follows :

"1 COMB"
"2 COMMB LINKED 2"
"3 TEST COMM-B LINKED 3"
"4 TEST COMM-B LINKED 4"
"5 .....TEST ELM COMM-D MESSAGE WITH 6 SEGMENTS ....."
"6 ..... TEST ELM COMM-D MESSAGE WITH 10 SEGMENTS .....
TEST ELM COMM-D MESSAGE WITH 10 SEGMENTS"

"7 ..... THIS IS A DOWNLINK MESSAGE FOR TESTING AN ELM WITH 16 SEGMENTS WITH APN = 1 ..... THIS IS A DOWNLINK MESSAGE FOR TESTING AN ELM WITH 16 SEGMENTS WITH APN = 1"
"8 AFR405 REQUEST FL345 AT NANTES WAYPOINT"
"9 SAB546 REQUEST DIRECT ROUTING ON FL240 AT PARIS/ORLY"
"10 TAP420 REQUEST METEO REPORT FOR EDDF"
"11 LUF345 REQUEST ATIS INFORMATION FOR LPPO"
"12 BRI345 REPORTING CB TURBULENCE AT FL300"
"13 THY345 REPORTING UFO AT BRETIGNY REGION"
"14 AFR345 REPORTING ALL FREQUENCIES OFF LINE INCLUDING EMERGENCY 119.1"

"15 TEST MESSAGE"

The general format for these messages in "MEX.TXT" is :

"xx yy"

Where :

"⇒	Message start indicator
xx ⇒	Message number (2 digits)
⇒	A space
yy ⇒	Message in capitals (max. of 208 characters)
"⇒	Message end indicator

For phrase coded messages, function keys F1 to F7 can be used. These actions take place after having depressed the <ENTER> key.

"q" or "Q"	Quit TDLP terminating all processes

5.3.4. DOWNLINK FORMAT

No operation requirements.

5.3.5. SETUP_EDITOR

5.3.5.1. When the process is started, the information existing in "SETUP" file is read and implemented. This information concerns the following 2 different aspects :

- Interrogator identification (DII field),
- ICAO airport codes for phrase coded messages.

DII IDENT zz DII <=16

REQUEST VOLMET AT ZONE : xxxx KEY F1

REQUEST TAF AT ZONE :	xxxx	"	F2
REQUEST METAR AT ZONE :	xxxx	"	F3
REQUEST PRELDG AT ZONE :	xxxx	"	F4
REQUEST SIGMET AT ZONE :	xxxx	"	F5
REQ. ATIS INFORMAT. FOR :	xxxx	"	F6
REQ. METAR INFORMAT. FROM :	xxxx	"	F7
REQ. METAR INFORMAT. TO :	xxxx		

Where :

xxxx → ICAO airport code

The user can modify these parameters by simply using keyboard keys. After any modification, type <ENTER> to validate.

5.3.6. UPLINK_FORMAT

No operation requirements.

5.3.7. UPLINK_DISPLAY

No operation requirements.

5.3.8. MEX_TXT_STATUS

No operation requirements.

5.3.9. MAIN_PROCESS

No operation requirements.

6. MEANS INVOLVED / TEST PROCEDURES

Two test environments were used for the TDLP. One using the TRT test bench available at the EEC and the other using the test chain mentioned in ***Figure No. 1*** with ORLY Mode-S radar. In this case, an end-to-end test could be performed, thanks to the ground data processor AGLAE kindly made available by the Centre d'Etudes de la Navigation Aérienne (CENA) and the Mode-S station which was kindly made available by the Service Technique de la Navigation Aérienne (STNA).

This cooperation became mature with the use of a remote terminal. This remote terminal installed in the CENA, not only controls the TDLP but also close the test chain which permits an autonomous proceeding for Mode-S tests with these characteristics.

7. CONCLUSIONS

The Test Data Link Processor based UNIX described in this note shows an increase of functionality and flexibility compared to the Test Data Link Processor (EEC Note No. 19/93) which was implemented in a DOS environment.

This added functionality and flexibility are demonstrated by the fact that the Test Data Link Processor based UNIX installed in a workstation in a network configuration provides the possiblity of working locally or remotely, of doing on line modifications of flight parameters, message text and radar identification. The TDLP philosophy (DOS version or UNIX version) in conjunction with the Advanced ARINC Card as a hardware platform can be transported to many other ARINC applications based on real time dialogue.

Therefore, the development of software tools is foreseen to test other AVIONIC equiment.

8. REFERENCES

EEC Note No. 19/93 - TEST DATA LINK PROCESSOR
by H.P. ENGLMEIER and J.M. MATEUS MARTINS

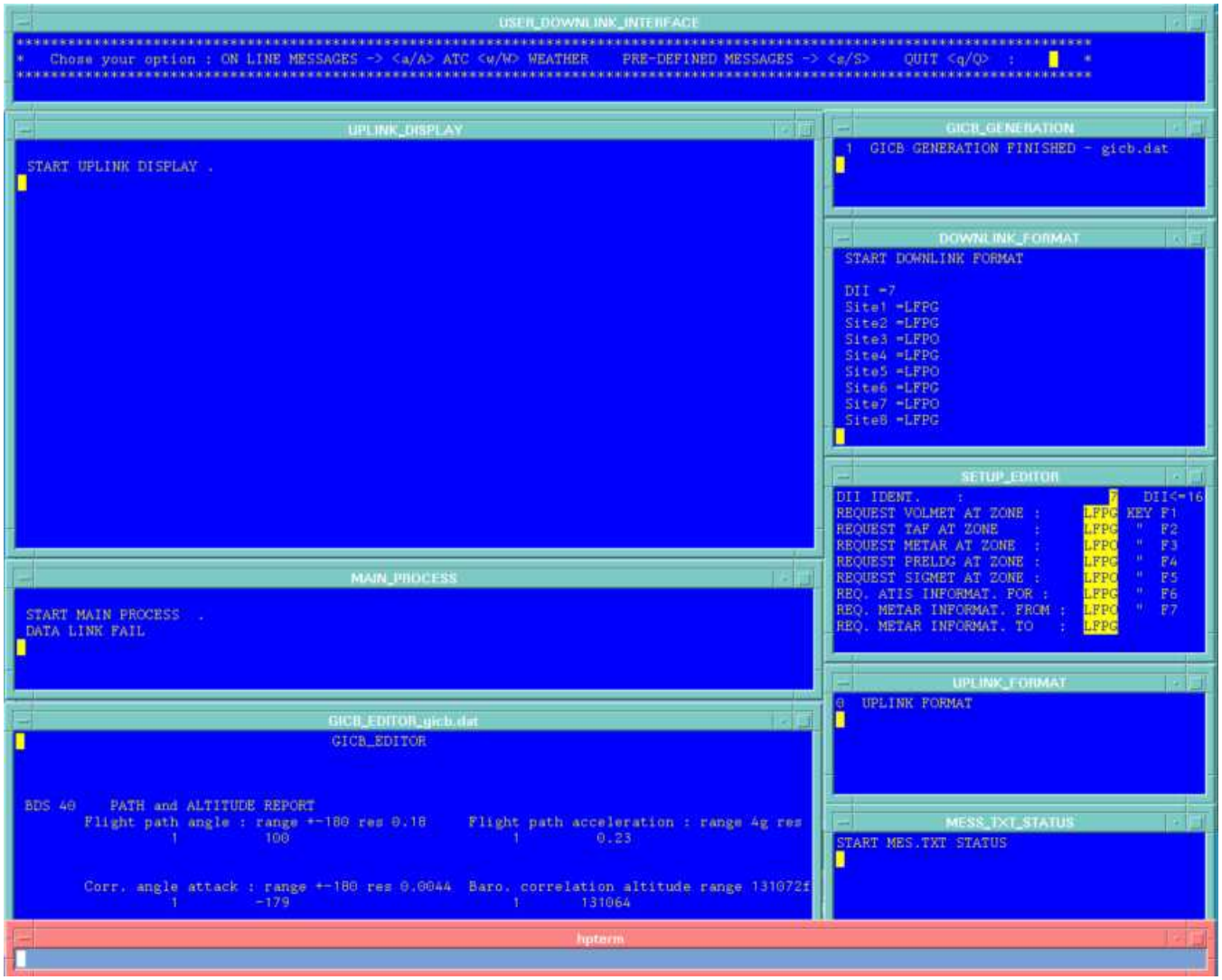
EEC Note No. 17/94 - ADVANCED PC ARINC CARD - VERSION 2
by H.P. ENGLMEIER

ARINC Document - MARK 3 Air Traffic Control
Transponder (ATCRBS / Mode S)

ARINC Characteristic 718-4, 15.12.1989

ICAO Aeronautical Telecommunications (Annex 10)

B.E.C. August 1994 by H. P. Englmeier and Joao M. M. Martins
Enter your GICB file name :


USER_DOWNLINK_INTERFACE
* Chose your option : ON LINE MESSAGES -> <a/A> ATC <w/W> WEATHER PRE-DEFINED MESSAGES -> <s/S> QUIT <q/Q> : *
UPLINK_DISPLAY
START UPLINK DISPLAY .
GICB_GENERATION
1 GICB GENERATION FINISHED - gicb.dat
DOWNLINK_FORMAT
START DOWNLINK FORMAT
DII =7
Site1 =LFPG
Site2 =LFPG
Site3 =LFPO
Site4 =LFPG
Site5 =LFPO
Site6 =LFPG
Site7 =LFPO
Site8 =LFPG
SETUP_EDITOR
DII IDENT. : 7 DII<=16
REQUEST VOLMET AT ZONE : LFPG KEY F1
REQUEST TAF AT ZONE : LFPG " F2
REQUEST METAR AT ZONE : LFPG " F3
REQUEST PRELDG AT ZONE : LFPG " F4
REQUEST SIGMET AT ZONE : LFPG " F5
REQ. ATIS INFORMAT. POR : LFPG " F6
REQ. METAR INFORMAT. FROM : LFPG " F7
REQ. METAR INFORMAT. TO : LFPG
MAIN_PROCESS
START MAIN PROCESS .
DATA LINK FAIL
UPLINK_FORMAT
0 UPLINK FORMAT
GICB_EDITOR_gicb.dat
GICB_EDITOR
BDS 40 PATH and ALTITUDE REPORT
Flight path angle : range +-180 res 0.18
1 100
Flight path acceleration : range 4g res
1 0.23
Corr. angle attack : range +-180 res 0.0044
1 -179
Baro. correlation altitude range 131072f
1 131064
MESS_TXT_STATUS
START MES.TXT STATUS
hpterm